**Comparative Study of RC Shear Resisting Structure By Non Linear Time History Analysis**

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***Abstract –*** *Structures need to have suitable earthquake resistant features to safely resist large lateral forces that are imposed on them during frequent earthquakes. Ordinary structures for houses are usually built to safely carry their own weights. Lateral forces can produce the critical stresses in a structure, set up undesirable vibrations and, in addition, cause lateral sway of structure, which could reach a stage of discomfort to the occupants. Shear wal, Steel bracings, infill wall, stiffer size columns are one of the most commonly used lateral load resisting element in high rise building. In this study, the non-linear El-centro time history analysis is carried out for special moment resisting frame under earthquake loading using computer software E-TAB 2016.*

***Keywords-*** *Shear wall, steel bracing, infill wall, stiffer column, Non-linear time history, E-TAB 2016.*

**INTRODUCTION**

Tall building developments have been rapidly increasing worldwide. The growth of multistory building in the last several decades is seen as the part of necessity for vertical expansion for business as well as residence in major cities. It is observed that there is a need to study the structural systems for R.C. framed structure, which resists the lateral loads due to seismic effect. Safety and minimum damage level of a structure could be the prime requirement of tall buildings. To meet these requirements, the structure should have adequate lateral strength, lateral stiffness and sufficient ductility. Among the various structural systems, shear wall frame or braced concrete frame and stiffer column could be a

point of choice for designer. Therefore, it attracts to review and observe the behavior of these structural systems under seismic effect. Hence, it is proposed to study the dynamic behavior of reinforced concrete frame with and without shear wall or bracings, RC frame with infill wall effect and RC frame with stiffer column size. The purpose of this study is to compare the seismic response of above structural systems. Axial forces and moments in members and floor displacements will be compared.

The most effective and practical method of enhancing the seismic resistance is to increase the energy absorption capacity of structures by combining bracing elements in the frame. The braced frame can absorb a greater degree of energy exerted by earthquakes.

The present study is an effort towards analysis of the structure during the earthquake. G+15 stories residential building is considered. Nonlinear time history method is carried out. For all the models mentioned above the base shear result are compared.

**METHODOLOGY**

In order to examine the exact nonlinear behavior of structures, nonlinear time history analysis has to be carried out. In this method, the structure is subjected to real ground motion records. This makes this analysis method quite different from all of the other approximate analysis methods as the inertial forces are directly determined from these ground motions and the responses of the building either in deformations or in forces are calculated as a function of time, considering the dynamic properties of the structure.

In Etabs 2016, the nonlinear time-history analysis can be carried out as follows:

1. The models representing the buildings are created and vertical loads (dead load and live load), member properties and member nonlinear behaviours are defined and assigned to the model.

2. The ground motion record is defined as a function of acceleration versus time.

Here after, the analysis and the time history parameters are defined in order to perform a nonlinear time history analysis. The total time of the analysis is the number of output time steps multiplied by the output time-step size. To match time history to target response spectra, there are two options in ETABS 2016.

**PROBLEM STATEMENT**

The building is analyzed is G+15 R.C framed building of symmetrical rectangular plan configuration. Complete analysis is carried out for dead load, live load & seismic load using ETAB 2015. Non linear time history analysis is used. All combinations are considered as per IS 1893:2016.

Site Properties:

Details of building:: G+15

Plan Dimension:: 30m x 20m , 5m span in each direction.

Outer wall thickness:: 230mm

Inner wall thickness:: 230mm

Floor height ::3 m

Parking floor height :: 3m

Seismic Properties

Seismic zone:: IV

Zone factor:: 0.24

Importance factor:: 1.2

Response Reduction factor R:: 5

Soil Type:: medium

Material Properties

Material grades of M35 & Fe500 is used for the design.

Loading on structure

Dead load :: self-weight of structure

Live load :: Floor :: 2.5 kN/m²

Roof:: 1.5 kN/m²

Seismic load:: Seismic Zone IV

Preliminary Sizes of members

Column::850mm x 350mm

Beam:: 300mm x 600mm

Slab thickness:: 125mm

Shear wall thickness:: 250mm

Steel bracing section::ISMB 350

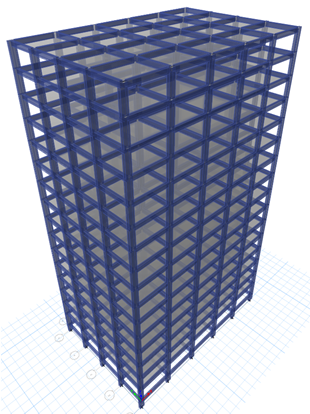
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Fig.1- 3D view of G+15 RC frame building

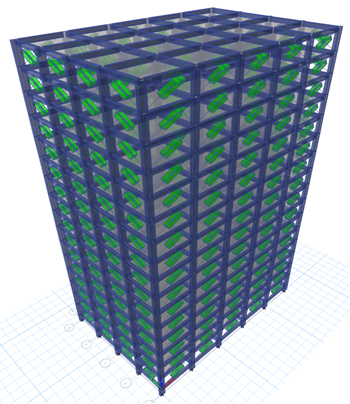
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Fig.2- 3D view of G+15 RC frame building with infill wall

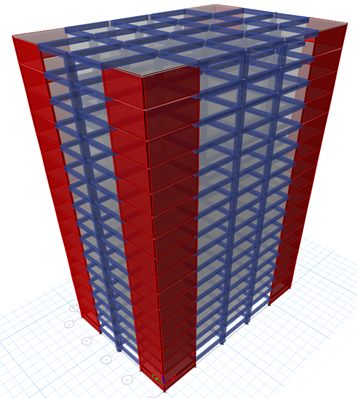
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Fig.3- 3D view of G+15 RC frame building with outer shear wall

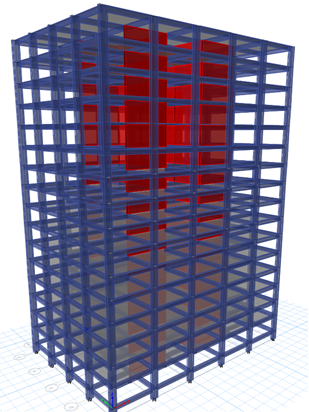
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Fig.4- 3D view of G+15 RC frame building with inner shear wall

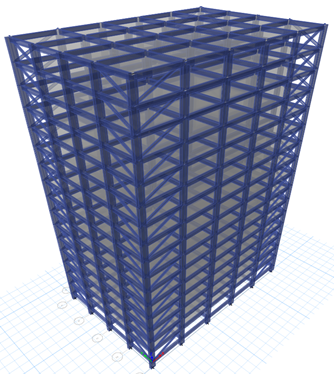


Fig.5- 3D view of G+15 RC frame building with outer diagonal steel bracing

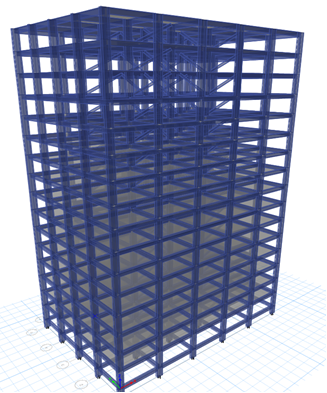


Fig.6- 3D view of G+15 RC frame building with inner diagonal steel bracing

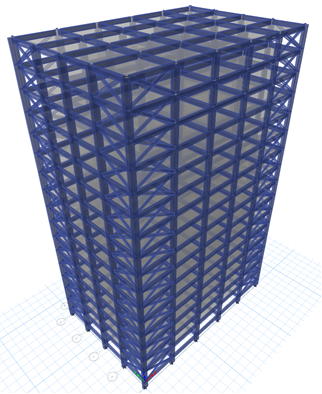


Fig.7- 3D view of G+15 RC frame building with outer X type steel bracing

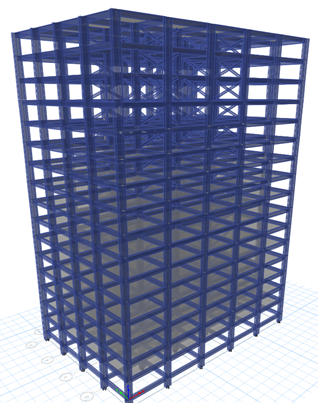


Fig.8- 3D view of G+15 RC frame building with inner X type steel bracing

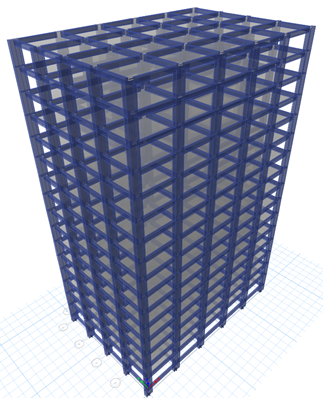


Fig.9- 3D view of G+15 RC frame building with stiffer column

**RESULTS**

Table 1- Base shear (kN) in X-direction

|  |  |
| --- | --- |
| **Type of Model** | **Base shear (kN)** |
| Bare Frame | 2625.722 |
| Infill wall | 3755.236 |
| Outer shear wall | 2729.949 |
| Inner shear wall | 4588.213 |
| outer Diagonal Brace | 1981.139 |
| Inner Diagonal Brace | 2012.569 |
| outer X Brace | 2391.413 |
| Inner X Brace | 2892.142 |
| Stiffer Column | 2751.883 |

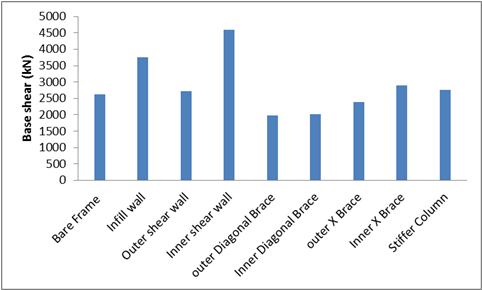
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Fig. 10 - Base shear (kN) in X-direction

Table 2 - Base shear (kN) in Y-direction

|  |  |
| --- | --- |
| **Type of Model** | **Base shear (kN)** |
| Bare Frame | 1817.95 |
| Infill wall | 2533.7 |
| Outer shear wall | 2104.625 |
| Inner shear wall | 2077.236 |
| outer Diagonal Brace | 2784.128 |
| Inner Diagonal Brace | 2485.21 |
| outer X Brace | 2886.541 |
| Inner X Brace | 1958.452 |
| Stiffer Column | 2872.971 |

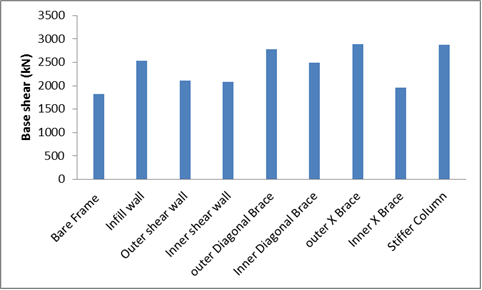
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Fig. 11 - Base shear (kN) in Y-direction

Table 3 - Maximum Lateral Displacement (mm) in X-direction

|  |  |
| --- | --- |
| **Type of Model** | **Ux (mm)** |
| Bare Frame | 35.457 |
| Infill wall | 16.095 |
| Outer shear wall | 15.747 |
| Inner shear wall | 22.749 |
| outer Diagonal Brace | 20.657 |
| Inner Diagonal Brace | 19.044 |
| outer X Brace | 21.555 |
| Inner X Brace | 22.633 |
| Stiffer Column | 28.224 |

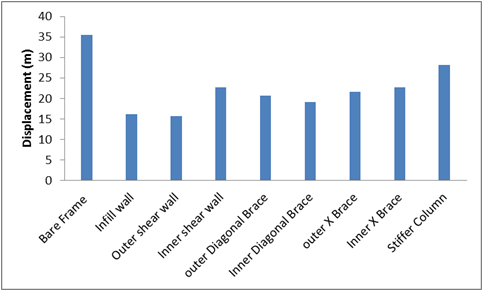
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Fig. 12 - Maximum Lateral Displacement (mm) in X-direction

Table 4 - Maximum Lateral Displacement (mm) in y-direction

|  |  |
| --- | --- |
| **Type of Model** | **Uy (mm)** |
| Bare Frame | 45.803 |
| Infill wall | 18.473 |
| Outer shear wall | 18.106 |
| Inner shear wall | 6.106 |
| outer Diagonal Brace | 43.074 |
| Inner Diagonal Brace | 30.409 |
| outer X Brace | 37.405 |
| Inner X Brace | 19.404 |
| Stiffer Column | 37.595 |

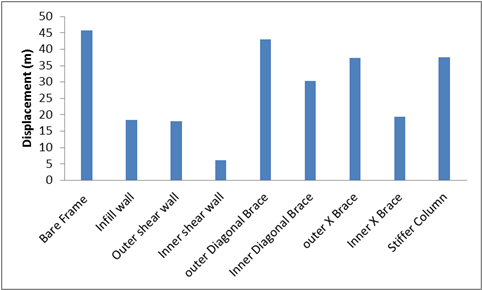
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Fig.13-Maximum Lateral Displacement (mm) in Y-direction

Table 5- Axial Force in columns (kN)

|  |  |
| --- | --- |
| **Type of Model** | Axial Force (kN) |
| Bare Frame | 3974.255 |
| Infill wall | 3715.238 |
| Outer shear wall | 3924.92 |
| Inner shear wall | 2737.464 |
| outer Diagonal Brace | 3970.048 |
| Inner Diagonal Brace | 4090.676 |
| outer X Brace | 3968.875 |
| Inner X Brace | 3986.89 |
| Stiffer Column | 3952.34 |

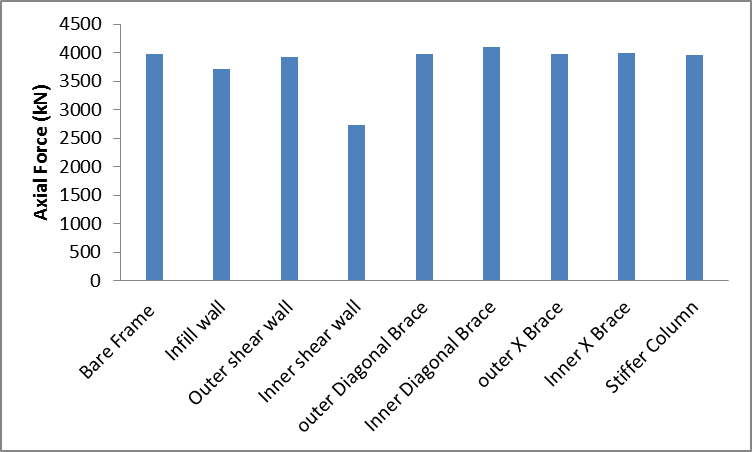


Fig.14 - Axial Force in Columns (kN)

Table 6.- Shear Force in columns (kN)

|  |  |
| --- | --- |
| **Type of Model** | Shear Force V2(kN) |
| Bare Frame | 131.2473 |
| Infill wall | 194.1598 |
| Outer shear wall | 102.2299 |
| Inner shear wall | 66.587 |
| outer Diagonal Brace | 213.5637 |
| Inner Diagonal Brace | 230.3087 |
| outer X Brace | 224.7055 |
| Inner X Brace | 259.6161 |
| Stiffer Column | 152.34 |

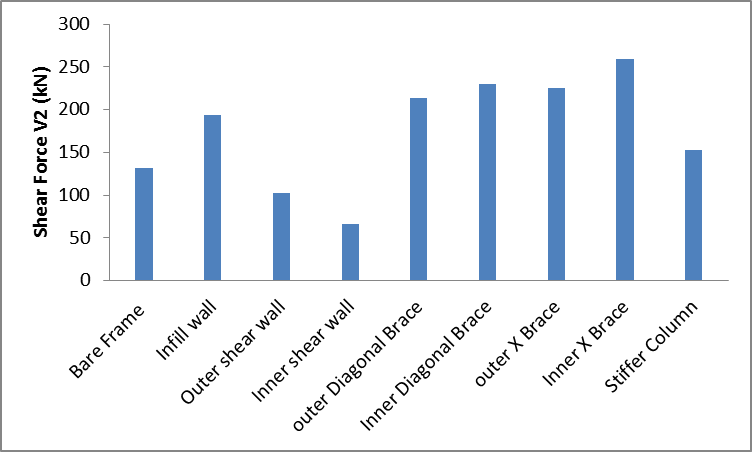


Fig. 15 - Shear Force V in Columns (kN)

Table 6 - Moment in columns (kNm)

|  |  |
| --- | --- |
| **Type of Model** | Moment M3 (kNm) |
| Bare Frame | 276.0882 |
| Infill wall | 292.0555 |
| Outer shear wall | 129.4382 |
| Inner shear wall | 102.116 |
| outer Diagonal Brace | 348.2895 |
| Inner Diagonal Brace | 340.554 |
| outer X Brace | 326.5206 |
| Inner X Brace | 347.4251 |
| Stiffer Column | 295.61 |

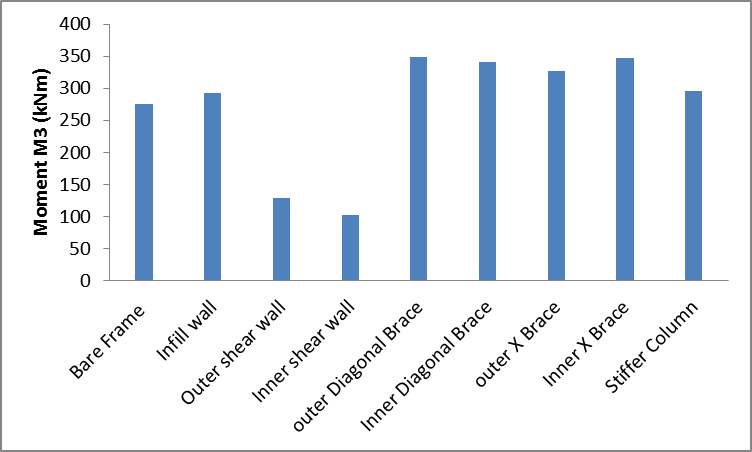


Fig. 16 - Moment in Columns (kNm)

**CONCLUSIONS**

1. **Base Shear** - Buildings with inner shear wall increased base shear upto 50% as that of bare frame in X direction. Also base shear is increased upto 40% in outer brace frame as compared to bare frame in Y direction and base shear is increased to 50% in vertical direction by adding inner shear wall.
2. **Lateral Displacement –** Maximum lateral displacement is reduced to 60% by adding infill wall in X direction and upto 85% by adding inner shear wall.
3. **Column Forces -** The critical axial force in columns is reduced to 30% by adding inner shear wall as compared to bare frame. Also shear force and moments in columns is reduced to 80% by adding inner shear wall as compared to bare frame

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